

24 March 1964

## DEVELOPMENT OBJECTIVES

### ADVANCED FILM-VIEWING LIGHT TABLE WITH A TRANSLATING MICROSCOPE CARRIAGE

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#### 1. INTRODUCTION.

These development objectives describe the requirements to be met in the design and development of an advanced film-viewing light table with a translating microscope carriage. The proposed table would replace the current models which cannot be adjusted to accommodate different operators. The present tables are generally awkward and uncomfortable to use and do not provide adequate illumination.

#### 2. CONCEPT.

This table is intended to provide ease of viewing, increased illumination, easy loading, an advanced film transport system and a superior method of translating a microscope over the viewing area of the table. It is to be as light, compact and simple in mechanical design as is possible within the parameters imposed by the specific requirements stated in these objectives.

#### 3. GENERAL DESCRIPTION.

This table shall provide an 11" by 40" illuminated area for use in viewing single rolls of  $9\frac{1}{2}$ ", 5" or 70mm film, or two rolls of either 5" or 70mm film. This unit will normally be positioned on an elevating or low, fixed table with the unit's viewing surface in a horizontal position, the long dimension extending to the right and left of the operator. The operator will work at the table as he would sit (or stand) at his own desk. Most operators prefer to position viewer close to the edge nearest their side of the supporting table. A movable carriage shall afford translation of a microscope over the viewing area.

#### 4. REQUIREMENTS.

##### 4.1. Illumination System.

##### 4.1.1. Intensity.

4.1.1.1. Range. At full intensity the illumination system must provide at least 1700 foot-lamberts measured at the illumination surface. 2000 lamberts is a definite design goal. Illumination shall not vary by more than 10% between any two points on the entire illuminated surface.

4.1.1.2. Variability. The intensity of illumination shall be continuously variable through a range of 15% to 100% of full intensity without visible evidence of "flicker".

4.1.2. Heat. The light table must be able to be operated continuously at maximum intensity over a 24-hour period, in a room with an 80°F ambient temperature, without exceeding 110°F on any external surface.

4.1.3. Diffuser. An opal glass or similar diffuser shall be located between the light source and the clear glass top.

4.1.4. Shades. Adjustable shades must be provided to mask out all of the viewing surface not actually covered by film. Each of these shades must be located beneath the surface glass, mounted along the long dimension of the unit and extendible across the short dimension. This extensibility must be continuously variable between a minimum extension of (0) zero inches and a maximum extension of 9 inches. These shades must not encroach upon the illuminated viewing area when retracted and, in addition, must be able to be locked in any extended or retracted position.

#### 4.2. External Configuration.

4.2.1. Size. The entire unit shall not exceed 55" in length and 20" in width. Width is exclusive of the crank handles but includes all the components of the translating carriage. The overall height of the light table shall not exceed 7" (minus the carriage, scope and reels). The carriage height shall be kept at a minimum.

4.2.2. Weight. The unit must be as light as possible without sacrificing good stability.

4.2.3. Height Adjustment. A superior adjustment system must be provided so that the entire table can be raised or lowered 3 inches."

4.2.4. Tilt Mechanism. A means must be provided for a 0° through 15° back-to-front tilt of the light table about its long axis. This motion must be simple, smooth, positive and must be able to be locked at any angular tilt within this range.

4.2.5. Comfortable Viewing Position. The light table, the translating carriage and the microscope adapter mounts must be designed to place each of the microscopes at a comfortable viewing height and in a comfortable working position. Human engineering factors should count strongly in the new design. It is understood, of course, that these positions also depend on the height of the illuminated surface, the requirement for the carriage to adequately clear the film and the varying working distances of the microscopes.

#### 4.3. Spool Loading and Holding Mechanism.

4.3.1. Loading Mechanism. A means for the fast loading and unloading of single spools of 9 $\frac{1}{2}$ ", 5" and 70mm film or two rolls of either 5" or 70mm must be provided. Rolls will range up to, and including, 500-foot capacity. This loading system must operate quickly and at the same time be positive in action: i.e., it must not drop the heaviest full spool (9 $\frac{1}{2}$ ", 500 feet) no matter how fast or hard the film is cranked. A drop-in film loading system is desirable.

4.3.2. Holding Mechanism. The holding mechanism which engages and secures the spool must be designed for easy one-hand operation -- so that the film can be held in one hand while the holding mechanism is activated with the other. A positive and yet quick release lock must be incorporated.

#### 4.4. Film Transport.

4.4.1. General. A unique film transport system shall permit bi-directional film motion controllable from either end: i.e., it will permit both winding and unwinding with the same crank at one end of the table. This transport system may be either mechanical or electro-mechanical; however, basic simplicity of design and complete reliability are mandatory. Consequently, a purely mechanical system is more desirable.

4.4.2. Film Capacity. The film transport system must accommodate either single rolls of 9 $\frac{1}{2}$ ", 5" or 70mm-wide film on either partially- or fully-loaded spools of up to, and including, 500-foot capacity. In addition,

provision must be made for handling two rolls of either 5" or 70mm film simultaneously. These rolls should be mounted side by side with a supporting post in between.

4.4.3. Film Direction. Film spools shall be located at both ends of the long dimension of the viewing area, with the film or films transported along (and parallel to) the long axis of the light table. When two rolls are used, the film strips will travel parallel to each other and to the long axis of the table, with a minimum of separation between strips.

4.4.4. Rollers. Rollers must be designed so that film can be transported either emulsion-up or emulsion-down without scratching. Either the rollers must be segmented or some alternative system provided so that when two rolls of film are used, the alternate rolls can be wound in opposite directions concurrently or one of the two rolls translated while the other roll remains stationary.

4.4.5. Film Tension. The film transport mechanism must maintain a light, constant, even tension on the film or films -- just enough to keep the film flat and in contact with the plate glass surface when the film is stationary. This tension should be automatically reduced or eased when the film is moved.

4.4.6. Film Drive.

4.4.6.1. Drive Modes. The film drive must: wind and unwind single rolls of 9 $\frac{1}{2}$ "-, 5"- or 70mm-wide film or two rolls of either 5" or 70mm film; be capable of winding one of the dual rolls while unwinding the alternate roll and/or permit one roll to remain stationary while the other roll is translated.

4.4.6.2. Drive Control. The drive control may be a hand crank or electrical switch; however, if an electrical control is used, it must provide the same degree of control sensitivity as a hand crank.

4.4.6.2. Dual Speed Range. A dual speed range with a high or "slew" speed shall be provided. This could be in the form of a two-speed, mechanical gear shift, a two-speed electrical motor, a variable lever arm crank or an electro-mechanical approach.

4.4.6.3. Reliability and efficiency. Whatever the system, it must be very reliable. Each individual hand crank must wind or unwind film very smoothly -- from either its own spool or the spool at the other end of the table. The drive must be a low-friction system which incorporates inertia damping and antibacklash features. The efficiency, reliability and ease of operation of this drive system is one of the most important considerations in this development.

4.5. Translating Microscope Carriage.

4.5.1. General. A carriage shall be provided for translating a stereo-microscope or microstereoscope in both X- and Y-directions over the illuminated format.

4.5.2. Amount of Translation. The optical center of the microscope shall scan an area of 10" by 35". This area shall be centered in the illuminated area, across the short dimension, and shall commence one-half inch from the right-hand edge of the illuminated area. (The right-hand edge refers to the operator's right as he faces the light table.)

4.5.3. Adapters must be provided for mounting three separate microscopes:

They must permit a rapid but stable mounting of any of the above units (with their attendant focusing mechanisms) upon the translating carriage. In addition, this mounting must permit an 180° rotation of each scope so that it may be used parallel to either the X- or Y-axis of the light table and from either long side.

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4.5.3.1. Carriage Motion. The carriage motion must be a smooth, positive, low-friction motion which is free of vibration ("chatter"). The friction load must be consistent throughout its range: i.e., a consistent pressure results in a consistent motion with no position of lesser or greater resistance.

4.5.3.2. Locks. Positive locks must be provided to lock the carriage in X and Y at any position of its 10" by 36" travel.

4.5.3.3. Fine Micrometer Motion. A fine micrometer X- and Y-microscope motion must be provided. The total travel of this motion must be  $\pm 2$  cm. in both X and Y. This motion shall be a precision, auxiliary motion accomplished once the main translational carriages have been locked in position. This precision motion must be graduated and easily readable. The motion shall be accurate to .001 mm plus .01% of the total distance being measured with a least count of .0005 mm.

4.5.3.4. Rigidity. It is mandatory that the carriage ways be of rigid construction to insure perpendicularity of the X- and Y-axis. These ways (or tracks) must be perpendicular and parallel to the extent that, when one end of the Y track is locked (so that it can not move in X) and a pressure of 5 pounds is applied to the other end (longest possible lever arm) of the Y track, it will not deflect more than .002 inches.

4.6. Miscellaneous.

4.6.1. Construction. Construction shall meet the highest commercial standards.

4.6.2. Shock Hazard. The unit must be grounded and free of all shock hazards.

4.6.3. Warning Light. A warning light must be provided to show when the unit is on even if the (table) light intensity is turned completely down.

4.6.4. Controls. All operational controls must be conveniently located and readily accessible to the operator. Human engineering factors must be thoroughly considered in the design and placement of these controls.

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This proposal describes a design approach achieving the design objective for an Advanced Film-Viewing Light Table with a Translating Microscope Carriage in accordance with Development Objectives dated 24 March 1964. In the event of an award, the first consideration in the design will be to make a complete human engineering and mechanical analysis to determine the simplest and most reliable approach consistent with the design objective. The final design will not commence until all parameters to meet the objective have been firmly established.

Basic Concept

In this design we have employed the use of thin wall ribbed aluminum castings to provide rigidity as well as strength. 356T6 aluminum is being considered. Although we are considering the use of fabricated metal and plate type construction for the light table, the cast material concept provides the freedom of design, allowing human engineering requirements to be most advantageously carried out. There is also the advantage of acquiring an aesthetically produced light table without additional cost.

The use of cast members will naturally provide economies in any future procurement.

The overall size of the table is 55 inches long, 20 inches wide and 7 inches high, minus the carriage scope and reels.

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### General Description

As shown in Figure 1, the Viewing Light Table is provided with an 11 x 40 illuminated area for viewing single rolls of 9 1/2" - 5" and 70mm film, or two (2) rolls of either 5 inch or 70mm film in 500 foot capacity. The Light Table contains the light source and power supply diffuser glass plate top mechanism for transporting film and associated controls, tilt and elevating mechanism, and translating carriages and adapters for microscopes.

### Detailed Description

Figure 1, displays a cross section of the Light Table showing the transparent top adjustable shade plastic diffuser light source and side channels for the transport mechanism. The top plate is made of glass with beveled edges.

The shades are made of synthetic rubberized fabric, mounted on rollers with the pulled edge of the shade supported between the diffuser and the glass top. The leading edges of the shades are metal edged for rigidity.

The shades are located at the edges of the long side of the table, extendable across the short dimension. The shades may be extended across the entire illuminated area from 0 to 9 inches from an edge. The shades are actuated by small belts over pulleys from knobs flush mounted near the top surface. A lock-in feature is provided.



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The diffuser will be an opal plastic. The light source will be a shock mounted cold cathode type with a variable illumination from 15% to 100% without flicker. The illumination will provide 1500 foot lamberts at the glass top surface. 2000 foot lamberts, or more, is a design goal. If the 110°F surface temperature of the top plate cannot be maintained with a heat sink, a small blower will be introduced to remove hot air. If a blower is needed, it will be a "muffin" fan type, which is essentially silent and vibration free.

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[ ] has manufactured a model [ ] Light Table with 10 inch x 20 inch illuminated area having a brightness level of 2,200 foot lamberts at its maximum setting. The temperature rise is 32°F when film having a density of 3.0, is placed on top of the table. When no film is present, then the maximum temperature rise is 20°F.

The above is presented to illustrate the investigations we are presently conducting. Such lamps are available for demonstration purposes.

The spool loading mechanisms consist of live driving centers, adjustable to pre-located key positions for selecting the proper size spool. One each is located at A-B-C-D. The live center will contain a gear which will remain meshed with a pinion. After it is moved, it will be locked in to the changed positions. The keyed pre-located positions will be identified by a mark for simplicity of locating.

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The center post is fixed, located on the center line of the long axis of the Light Table. It is hinged so that it may be moved out of the way when 9 $\frac{1}{2}$  inch spools are used. A simple locking device will be used to hold it in position when 70mm or 5 inch spools are used. The pivot center on the center post between the spools will be made of hardened steel for durability. The advantage to pivoting the center post, is that it eliminates the possibility of misplacement or accidental loss of the part.

As shown in Figure 1, the Light Table will accommodate one (1) 9 $\frac{1}{2}$  inch dual 70mm or 5 inch spool, or one (1) 70mm and one (1) 5 inch spool.

Segmented rollers are used so film may be transported with emulsion side up or down, or in various widths simultaneously.

The film transport proposed is purely mechanical, providing the necessary directional travel functions. A two (2) speed mechanical gear shift for one to one (1:1) ratio and three to one (3:1) for slewing is provided for two spools at one end of the table.

The configuration of the dual spool drives can be selected as one of two alternate approaches, separately shown in Figures 3 and 4. Each approach has its own merits, and separate evaluation will be made  during the design phase to determine the comparable reliability and human engineering advantages, after which a selection may be made as to the optimum approach by the activity.

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Alternate Approach "A"

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This approach utilizes two (2) hand cranks, Nos. 1 and 2, as shown in Figure 3. However, either of these hand cranks achieves the same operation so that the operator may rotate any of the film spools simultaneously, or separately with either of the two cranks. Any one of the cranks drives through a single dual speed mechanism. A lever allows the selection of speed, one to one (1:1) and three to one (3:1) ratio. The output of the dual speed mechanisms is connected to two (2) mechanical clutches to drive the two (2) films. The first clutch actuates spools A and B. The second clutch energizes spools C and D through reversing mechanism, which can select either direct or opposite directions. Levers are provided in one handle to select the following:

1. The first clutch may be decoupled so that only spools C and D are driven.
2. The second clutch may be decoupled where only spools A and B are driven.
3. Both clutches are coupled where A-B-C-D are driven. If the reversing mechanism is selected to be (direct) then the two films are advanced in the same direction. However, when the reversing gear is introduced, then film in spools A-B will be driven opposite as to the spools C-D.

This approach allows the operator to use one hand only to achieve all the required operations. If he is right handed then he uses the right hand only. If he is left handed, he uses the left hand only. He may also select to drive either films separately, together or opposite each other by the lever mechanisms.

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The four (4) clutch boxes shown in Figure 3, are illustrated in Figure 5, each contains a unidirectional clutch, which allows slippage in one direction and direct drive in the opposite direction. When the unidirectional clutch slips, friction is introduced so that a slight drag is provided on the free wheeling spool. The clutch mechanism provides the reversal of unidirectional clutch by a reversing mechanisms. Thus, if the spool is loaded, (as shown in Diagram A, Figure 6) then the right hand spool is allowed to be driven clockwise and is free wheeling counter-clockwise. The left hand spool is allowed to be driven counter-clockwise and is free wheeling clockwise. On the other hand, if the film is loaded, as in Diagram B, then the right spool is allowed to be driven in the counter-clockwise direction while slipping in the clockwise direction. The left hand spool is allowed to be driven in the clockwise direction and free wheels in the counter-clockwise direction. The switching from Diagram A to Diagram B must be associated with the reversing of clutches in the manner shown in Figure 5, by a reversing mechanisms, which allows the same direction of motion to the operator relative to the hand crank. Thus, as he turns his hand wheel clockwise he moves this film to the right, independent of whether he has the spool loaded as in Diagram A or Diagram B. As he turns his hand wheel counter-clockwise, he moves the film to the left.

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Alternate Approach "B"

This alternate approach utilizes two (2) independent hand wheels. One hand wheel is allowed to actuate the film in spools A and B and the other hand wheel independently actuates spools C and D. The four (4) clutch boxes actuating each spool are the same as described previously. These clutch boxes allow the full control of any film with one handle so that if he rotates the handle clockwise he moves the film to the right, if he rotates the handle counter-clockwise he moves the film to the left. The same provisions are made so that the spool can be placed so that the emulsion of the film is either Emulsion In or Emulsion Out, or Emulsion Up or Emulsion Down on the viewing table.

Light constant tension on the film when stationary will be retained through the friction clutches located on the four (4) retractable live center shafts at A-B-C-D.

A novel scheme is provided to automatically lift the film from the glass plate when it is driven. The film drive is actuated by pushing in with slight pressure, the segmented rollers at both sides of the light table are lifted to automatically move the film away from the glass plate. As soon as the hand wheel is released, the segmented rollers will drop to original position, putting slight tension on the film. This automatic tensioning is realized since the movable roller is brought down against an upper fixed roller, providing a constant controllable tension on the film.

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In the film transporting position, the hand wheel is keyed to the shaft driving the spools. When film is being viewed, the hand wheel is not engaged to the shaft, eliminating the possibility of moving film during this mode and preventing the possibility of scratching the film.

Tension is automatically removed when film is transported.

### Tilt Mechanisms

The elevating mechanism will comprise of four (4), one (1") inch diameter, acme threaded screws, mounted at four (4) corners of the Light Table. Each screw will terminate in a universal captive ball joint pad for support, which will remain flat regardless of tilt. The two screws in the back are geared together through a glimer belt, or equivalent, so that if one rotates the right side, the left automatically follows. The front two screws are linked in the same manner. Thus, to raise the table, the front and back is lifted together by rotating a folding crank (or large knob). The entire table can then be raised or lowered three inches.

The table can be tilted by  $\pm 15^\circ$  by rotating either the back knobs or cranks.

This approach requires only one hand for the raising and lowering operation.

The tilt table will be electrically grounded to prevent shock hazard.

Warning light and intensity control will be on the cast base and human engineered for the most appropriate location, regardless of tilt.

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### Translating Microscope Carriage

Very careful consideration has been given to the Translating Microscope Carriage design in view of the requirements of paragraph 4.5.3.4 rigidity to meet the deflection specification the rail design will utilize the strength and rigidity of the light box casting as a continuous support under the rails.

As shown in diagram, Figure , each rail will be made of flat, hardened and ground steel for durability and chrome plated for corrosion resistance. The rails will run the entire length of the light box and will have a probable cross section of 3/8" x 1 1/2" and adequately secured to the light box casting.

The Translating Carriage will be made of cast meehanite, ground and lapped for accuracy.

The X Carriage, as illustrated, will have a three point ball bearing support on the rails; two bearings at the rear and one bearing at the front. The rear bearings will be rigidly mounted to eliminate backlash. The X Carriage will have a dovetail accommodating a plate which is the substage for  $\pm 20\text{M}$  of movement in the X axis after the translation in this axis has taken place.

The top surface of the X substage carriage has a dovetail machined in its top surface.

The Y Carriage slide fits in this dovetail to permit translation in Y motion. One side of the dovetail carries spring loaded ball bearings to eliminate backlash.

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The Y Carriage slide also carries a subplate which serves as the rotating mount for the microscopes.

Each microscope will have its own adapter which can be inserted into the Y Carriage slide and rotatable for 180° for use parallel to either the X or Y axis of the Light Table and from either side.

The X and Y substages will contain 1mm pitch precision screws accurate to .001mm + .01% of the total distance being measured. The dials will be of sufficient diameter to permit a least count reading to .0005mm. A scale graduated in 1mm increments will be used to count the number of revolutions of the calibrated dial.

Both X and Y Carriages are equipped with positive locks when measurements lock.

Microscopes are not furnished as a part of this proposed equipment.



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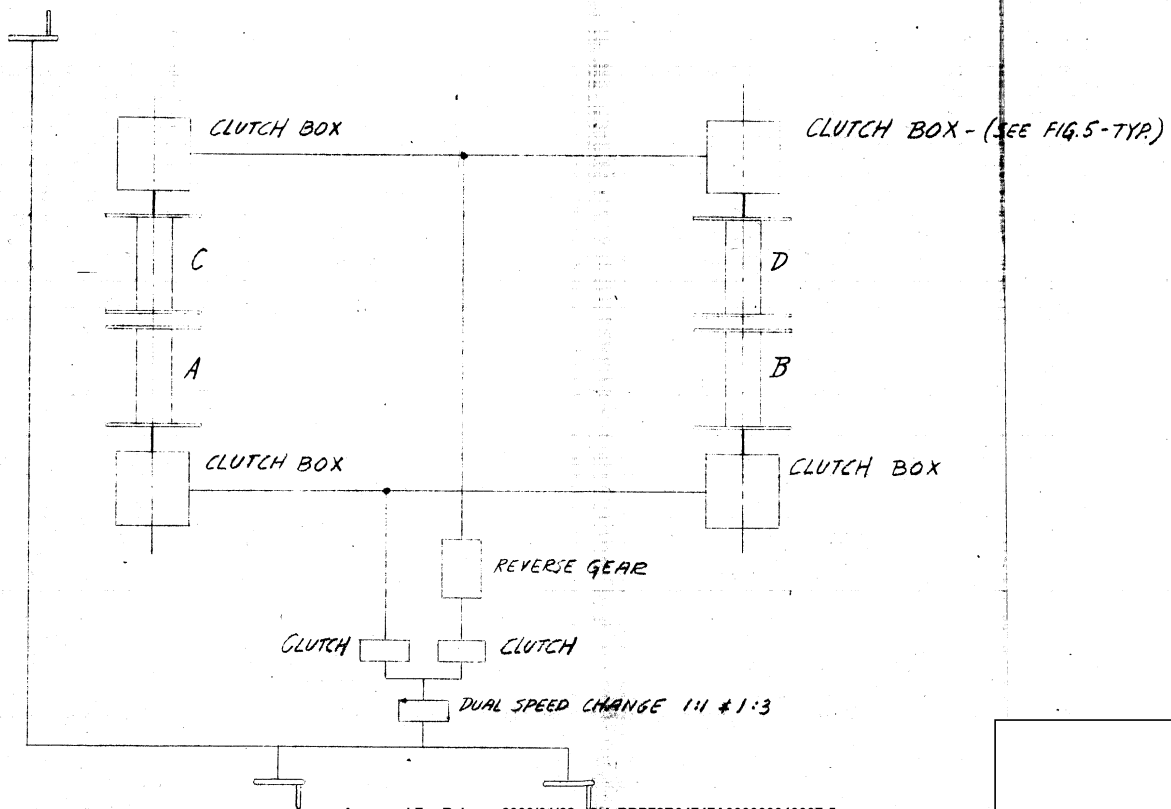
CONCLUSION

This proposal presents a unique approach to achieve the design objective, which is purely mechanical. It can be readily seen from the approach presented that a completely reliable mechanical device can be made without the use of motors or electromagnetic devices.

Other design approaches will be studied to maintain simplicity and reliability.

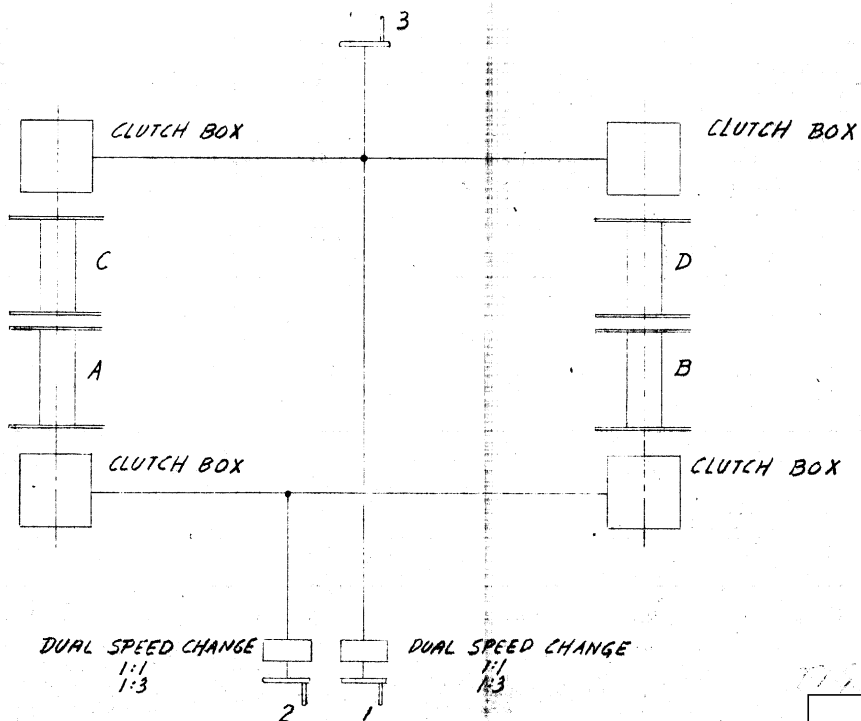
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FIG. 3



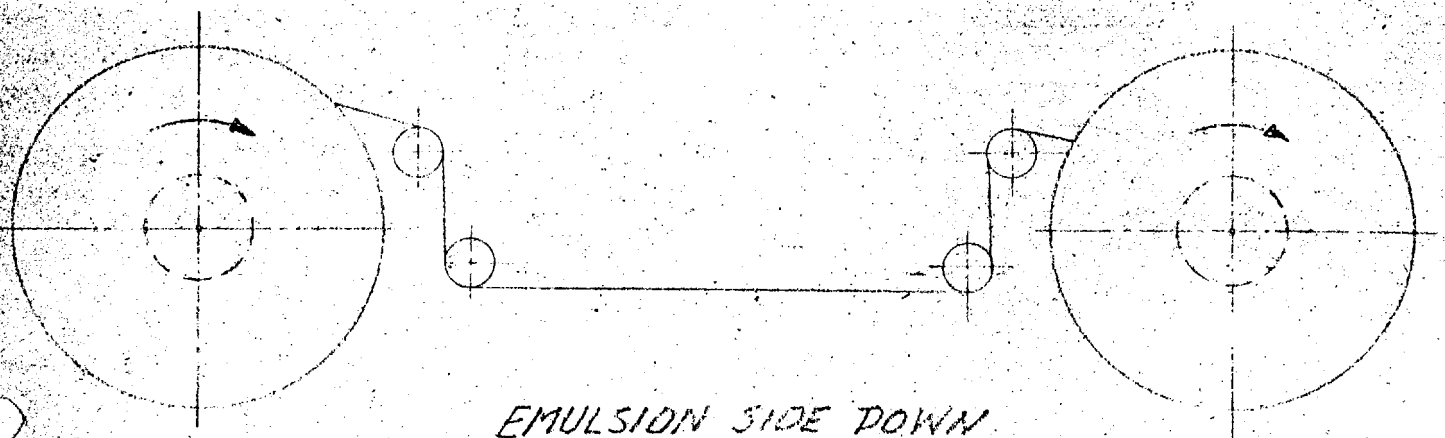
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FIG. 4

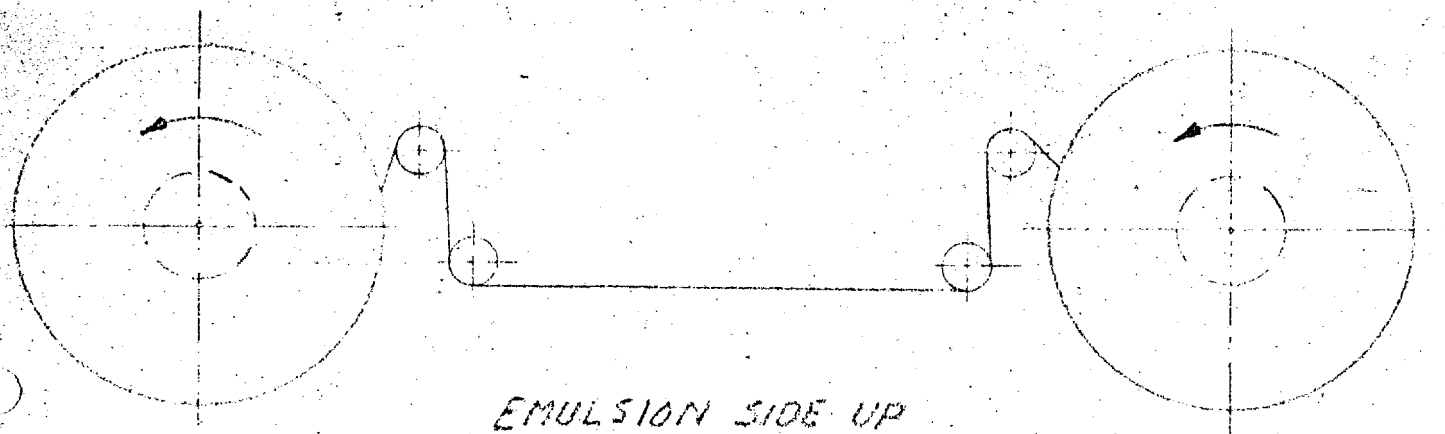
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